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THE VITREOUS BODY AND GLAUCOMA*

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OF the variety of theories put forward to explain the raised intra-ocular pressure in primary chronic glaucoma, that suggested by one of us (Duke-Elder, 1930) to the effect that a swelling of the vitreous body is the prime agent in the process has found a fairly wide acceptance. This theory was put forward because it could account for such symptoms as the shallow anterior chamber† and the atrophy of the choroid and ciliary body in glaucoma, and appeared reasonable from a physico-chemical aspect in view of the gel nature of the vitreous body. The experimental evidence relating to this theory which has accrued since has been conflicting and often equivocal in its interpretation. Thus Baurmann (1924) and Löbeck (1929) failed to find any change in volume of the vitreous body on varying its reaction within narrow limits;

* The blocks illustrating this article have been kindly loaned by the *Biochemical Journal*.

† Gonioscopic examination has demonstrated the possibility of a raised intra-ocular pressure with the drainage angle completely free. In these cases, if the vitreous was swelling, no rise in intra-ocular pressure could be expected from this cause unless some upset in the permeability of the membranes lining Schlemm's canal occurred at the same time.

Redslob and Reiss (1928) found considerable variations in the total volume of the intact eye in a modified dilatometer on varying the P*h*, and Duke-Elder (1930) described variations in volume of the isolated vitreous body which were thought to demonstrate the possibility of a swelling of the vitreous under suitable conditions. The evidence to be brought forward in this paper allows of a different interpretation of these last results. Glaucoma, however, is not associated with any detectable abnormality in the P*h* of the blood (see *e.g.*, Schmerl, 1928), so that experiments on the variation of this factor are only of interest to the extent that they show that the vitreous body is capable of modification of its volume in response to a changed environment. What can be made to occur in a test-tube need not necessarily occur in the living body.

A factor in the swelling of proteins often more potent than the P*h* is the presence of specific ions, *e.g.*, I- or CNS-, or the so-called hydrotropic substances of Neuberg (1916). The recent work of Katz (1933) on the swelling of starch and gelatin has shown that substances such as the sodium and potassium salts of long-chain fatty acids, and, in general, dipolar substances with both hydrophilic and hydrophobic groups in their molecules, will increase the rate of swelling to an enormous extent. Since the increased swelling so produced is due to adsorption on to the micelles of the colloid, it is obvious that these substances may be effective in low concentrations, and hence it is not impossible that they are effective in the causation of glaucoma. The occurrence of abnormal quantities of substances of a soapy nature in the eye in advanced glaucoma and similar degenerative conditions of the eye lends support to this view.

In this paper attention will be focused entirely on the physico-chemical properties of the vitreous body in so far as they relate to the possibility of its swelling *in vivo*. In a later paper the adequacy of the theory from an ophthalmological point of view will be discussed in conjunction with a new theory based on different physico-chemical assumptions.

PART I. DIRECT SWELLING EXPERIMENTS ON THE VITREOUS BODY.

The apparatus of Schmidt (1931), used for the determination of the water-uptake of powders, was modified (Duke-Elder, Robertson, and Davson, 1935) to suit the peculiarities of the vitreous body (see Fig. 1). The tap, T_1, allows connections to be made between the reservoir, R, and the capillary, C; between R and the chamber, P; between P and C, and between R, P and C. The vitreous body is placed in the chamber, P, which is separated from the fluid in the rest of the apparatus by a sintered glass disc, S, which has a mark on it showing the level of the tap, T_1. Any uptake of water is measured by the movement of the meniscus in the

capillary. The procedure is to fill the reservoir with the given solution and make connection, with T_2 open, to P and C until fluid flows through T_2 when the latter is closed and connection is made between R and C alone until the latter is half filled. T_1 is then half-turned so that no connections are made, and the vitreous body of an ox is placed in P to just above the mark. When T_1 is turned to make connection between P and C the meniscus will move along the capillary to the right, due to the slight excess of hydrostatic pressure in P. To counteract this the whole apparatus is tilted slightly as the tap is turned so that the meniscus stops after it has moved a few inches. The tilting must not be

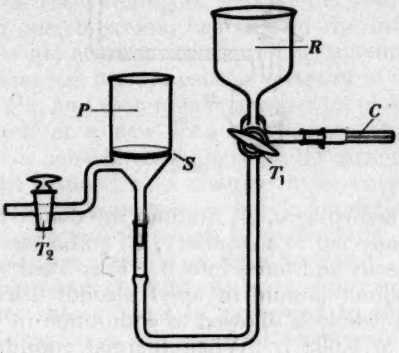

FIG. 1.

so steep that the meniscus starts to move backwards, otherwise water will enter P and the experiment must be started again. Solutions of 0·9 per cent. NaCl buffered with phosphate to P*h* 7·8 and 8·0 and solutions of 1 per cent. sodium oleate and laurate were used.

In all cases no water-uptake was observed in 24 hours. As will be appreciated, the apparatus described determines whether the gel takes up water, but not whether a volume increase occurs, although the one process is always associated with the other. Küntzel (1929) has divided the swelling process of gels into two parts, one due to water-uptake and the other due to the mutual repulsion of charged micelles. In view of the possible independence of the two processes at certain stages of swelling it was thought that there was just a chance that the vitreous body might alter its volume by a re-orientation of the charged micelles, produced by the adsorption of a polar compound, without necessarily taking up water. To put this to test, the apparatus shown in Fig. 2 was devised.

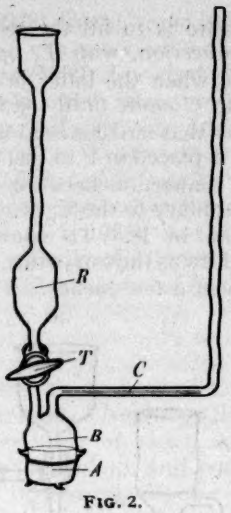

FIG. 2.

The hollow hemisphere, A, fits into the dome, B, by a ground joint. B is connected to a capillary, C, and a reservoir, R. A is filled with vitreous and fitted into B. R is filled with a saturated solution of sodium laurate in amyl alcohol dried with sodium sulphate. The whole is allowed to equilibrate in a thermostat at 25° (constant to 0.002°). When thermal equilibrium has been established the tap T is turned and the solution is allowed to fill B and run along the capillary tube. The tap is turned off and the position of the meniscus fixed on the cross-wires of a telescope. Any increase in the volume of the vitreous due to the adsorption of sodium oleate from the amyl alcohol would be registered by a movement of the meniscus to the right. A control was run using pure dry amyl alcohol. Repeated experiments failed to show an increase of volume; in general a slight contraction in both control and test experiments was observed.

The absence of any water-uptake near Ph 8 in the first experiment is in agreement with the findings of Löbeck; the experiments with soaps show that under more extreme conditions than that of changed Ph the vitreous body does not increase in volume in 24 hours.

PART II. INDIRECT EXPERIMENTS.

The results of Part I can hardly be treated as absolutely demonstrating that the vitreous body is incapable of increasing in volume in primary chronic glaucoma, as the increase in intra-ocular pressure associated with this disease is usually slow, frequently

taking years to reach its maximum value. So far two possible theories of the mechanism of volume increase have occurred to us depending on different conceptions of the mode of origin of the vitreous body. First, if it is assumed that the vitreous is formed by a continuous process of swelling from an initial dry protein similar to the process of swelling of dry gelatin in water, then, considering it as at its swelling maximum at normal P*h*, it seems possible that it could swell further if the P*h* were altered in a direction favourable to increased hydration.

All previous experiments designed to show whether the vitreous body swells have tacitly assumed the truth of the latter proposition. However, although the colloid chemical literature contains many studies on the swelling of gels in the presence of foreign substances, no one, it seems, has studied the influence of these substances on a gel already at its swelling maximum. The procedure in all cases has been to cause a quantity of the dry material to swell at one P*h*, and then to take another lot of dry material and cause it to swell at a new P*h*, and so on (Duke-Elder, 1930 and others). On consideration, it is by no means evident that a swollen gel will respond to a change in its environment to the same extent or in the same way as the dry material, owing to the intervention of peptisation which is particularly to be expected when the micelles are already strongly hydrated.

If, on the other hand, the vitreous body is formed by a sol-to-gel change, another theory must be presented to show how it can swell.* In this case it is suggested that a minute fraction of the vitreous body is peptised owing to the presence of some lyophilic substance; if, then, the procedure is reversed whereby the comparatively protein-rich fluid is converted to its gel form, the presence of the adsorbed lyophilic substance enables the protein to orient more water than previously. The net result of this cyclical process is an increase in volume. If this were to proceed over a number of years the effect would be to produce the pressure symptoms characteristic of chronic glaucoma. The process may be illustrated in a crude way by placing a lump of 10 per cent. gelatin in a small volume of water. Addition of acid produces eventual peptisation; neutralization of the acid converts the sol back to a gel larger in volume than before. (The objection that the increased pressure will expel fluid after the peptisation of a portion of the vitreous body is overcome by postulating a unidirectional permeability of the surrounding membranes. This is not a further *ad hoc* assumption as some such state must be the case as will be shown in a later paper). Part II of this paper is

* Experiments of our own on gelatin clots, as yet unpublished, together with theoretical considerations lead to the conclusion that a dilute clot, as opposed to a swollen gel, will not increase in volume directly when its environment is changed.

divided into three sections according as the experiments throw light on the possibility of a gel at its swelling maximum swelling further on changing the *Ph* suitably (Section 1), on the structure

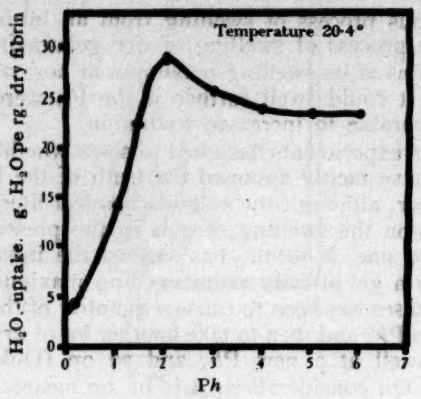

FIG. 3.

of the vitreous body and hence its mode of origin (Section 2), and on the possibility of peptising the residual protein (Section 3).

Section 1. *Swelling of fibrin.* In Fig. 3 the water-uptake per g. of dry fibrin, as determined in a Schmidt apparatus, is plotted

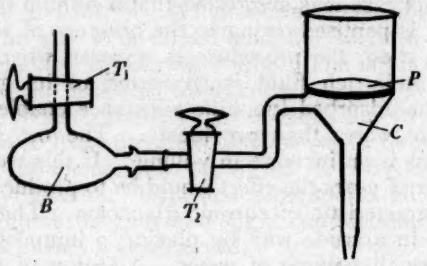

FIG. 4.

against *Ph*. From the curve it is evident that by allowing fibrin to swell to its maximum at *Ph* 6 and then changing the medium to one of *Ph* 2 the conditions necessary to show whether a gel at its swelling maximum can take up further water by changing the *Ph* favourably will be achieved.

To this end the Schmidt apparatus was modified as in Fig. 4 (Duke-Elder and Davson, 1935). A bulb B with a tap T_1 fits on the side-tube by a ground joint. With T_2 closed the bulb is filled with concentrated HCl and T_1 is closed. Fibrin is placed on the

porous plate, P, and, when the water-uptake, as measured by the movement of a meniscus in the capillary in communication with the chamber, C, has reached its maximum the tap T_1 is opened allowing acid to diffuse in, thus lowering the P*h* of the fluid in contact with the swollen fibrin. In Fig. 5 the water-uptake is plotted against time. For convenience the initial part of the curve is not shown and the scale of ordinates above 2·8 ml. is a half of that below this value. Obviously the swollen fibrin adjusted itself to the changed P*h*. If the acid had not diffused in, the water-

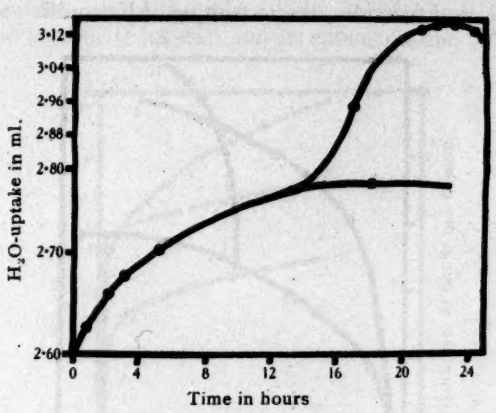

FIG. 5.

uptake would have reached a final value of 2·80 ml., whereas, owing to the changed acidity, it rose to a maximum of 3·18 ml.

Swelling of gelatin. Gelatin was allowed to swell at P*h* 4·8, the isoelectric point, at which P*h* swelling is minimal, and at P*h* 1. Pieces of gelatin which had already swollen at P*h* 4·8 were transferred to the solution of P*h* 1 and their subsequent swelling followed. In Fig. 6, I and II are the swelling curves of gelatin in solutions at P*h* 1·1 and 4·8 respectively. The upper branch of curve II represents the change in the rate of swelling on transferring the gelatin from a medium of P*h* 4·8 to one of P*h* 1·1. It is at once evident that the swollen gelatin has adjusted itself to the changed P*h*.

In the light of these experiments the truth of the first assumption, made tacitly in all earlier experiments on the vitreous body, to the effect that a gel at its swelling maximum for certain conditions can be expected to increase in volume at all, is demonstrated. Hence if the vitreous body is formed by a continuous process of swelling without the intervention of a sol stage, the presence of soaps in

the surrounding tissues would favour an increased volume of the vitreous body.

Section 2. The structure of the vitreous body. Goedbloed (1934, 1) described ultra-microscopic changes in the vitreous on treatment with KCNS solutions which he interpreted as being due to an increased hydration of the micelles. If such were the case a change in the elastic properties of the vitreous body on treatment with this substance would be expected. To test this two techniques were used, first, the resistance of the treated vitreous body to the emulsification of Hg by ultra-sonic waves was compared with that of a control, and secondly, the technique of Freundlich and Seifriz

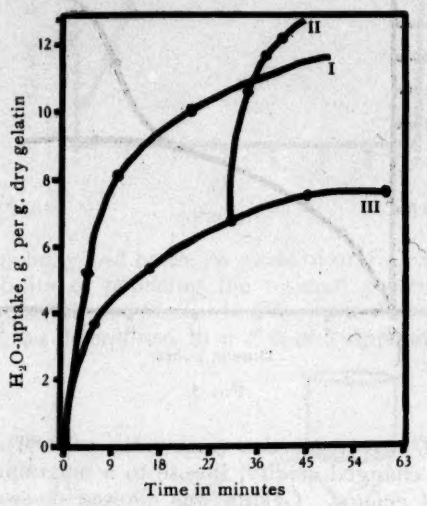

FIG. 6.

(1923) for the measurement of the elastic properties of gels, as modified by Robertson and Duke-Elder (1933) to suit the peculiarities of the vitreous body, was used.

Ultra-sonic waves. When water and Hg are submitted to ultra-sonic waves an emulsion of Hg in water is immediately formed, the whole mixture taking on a dark grey colour; if the water is replaced by a jelly the elastic properties of the latter hinder the emulsification of the Hg, so that after a given time there is a fairly well defined boundary between the clear jelly and that in which Hg particles have penetrated. The height of this boundary gives a rough idea of the elasticity of the jelly.

Ox vitreous was placed in 1·0 M, 0·5 M, and 0·14 M solutions of KCNS and in isotonic saline for 24 hours at 20°. They were

transferred to test tubes and 1 ml. of Hg added, and the tubes were held in succession over the vibrating column of oil above the quartz plate of the ultra-sonic apparatus. The heights of the emulsified Hg columns were compared.

There was no detectable difference in the heights of the columns of the vitreous treated with KCNS and of those treated with normal saline, so that it is concluded no very gross changes in the elastic properties of the vitreous body are caused by KCNS.

Nickel particle technique. Vitreous is placed in a rectangular glass cell 1 cm. edge and a nickel particle about 50 diameter is picked off a slide under the microscope and stabbed into the vitreous. The particle is focused and its extension due to an applied

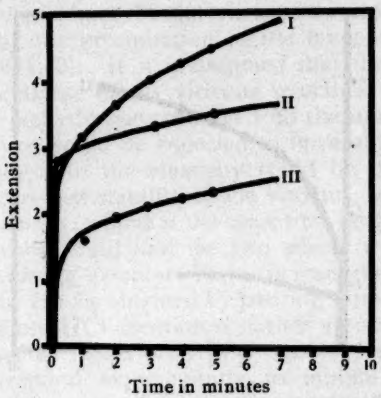

FIG. 7.

magnetic field measured by a micrometer eye-piece. Portions of vitreous treated with KCNS, K_2SO_4, and dilute HCl at P*h*3 were studied together with normal untreated vitreous. The results are shown in Figs. 7 and 8. Curve I, Fig. 7 is the typical extension-time curve for normal untreated vitreous, characterized by a rapid initial elastic displacement followed by a viscous creep approaching a fairly constant velocity.

Before describing the remaining curves a few words must be said in regard to the limitations of the technique and the results expected should a hydration or dehydration of the colloid particles be achieved by the solutions mentioned. Firstly, a direct comparison of the absolute displacements of one given particle in different lots of vitreous in a given time and a fixed field strength is difficult, as a particle of the size necessary for its recovery from the first vitreous is very irregular and its extension will depend on its direction of motion. Furthermore, as the vitreous

is not stuck firmly to the cell walls there will be a certain amount of 'give' which will vary with the quantity of vitreous in the cell and the depth of the particle in it. On the other hand, the curve I, Fig. 7, is very typical and can be reproduced from vitreous to vitreous without difficulty. As far as the changes expected on treatment of the vitreous with the reagents mentioned are concerned, from the work of Leick (1904) and Kramer (1926) a decrease in elasticity is to be expected with K_2SO_4 and an increase with KCNS. This should be reflected in a diminution in the viscous creep, characterized by the upper part of the curve, in relation to the initial displacement, in the case of K_2SO_4 which normally acts as a dehydrating agent, and the reverse should hold

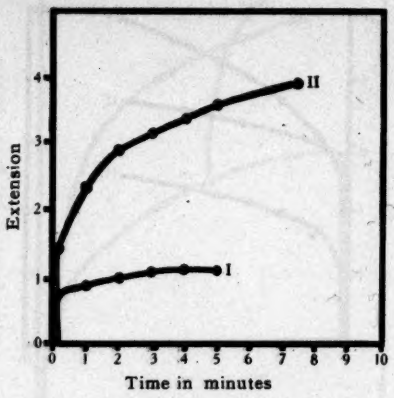

FIG. 8.

for KCNS. (Once again no work has been done on the effect of such solutions on gels already formed; workers in this field have added the substance to be examined to the sol which was then allowed to set, and the elastic modulus measured).

Curves II and III of Fig. 7 are those for vitreous treated with 0·5 M KCNS and K_2SO_4 respectively. They are representative of a number of curves determined similarly, but it should be mentioned that a few curves were obtained not conforming to these types; the reason for these irregularities, which were not observed in normal vitreous, will be brought out later. The displacements in the different curves are in no way comparable with one another as different particles were used. It is evident that 0·5 M KCNS has the reverse effect to that expected on the supposition that it increases hydration, the extension subsequent to the first 10 secs. being very small compared with that during this time. 0·5 M K_2SO_4 has no appreciable effect on the extension-time curve. The absence

of effect in this case is very surprising as a considerable contraction in volume was observed. The curves for isotonic solutions of these salts (not shown) were in general similar to those for normal vitreous. The curves obtained with vitreous treated with dilute HCl at P*h*3 (Fig. 8) throw a little light on the problem. Curve I occurred by applying a small magnetic force; increasing the field strength with conditions, otherwise the same, gave Curve II which is quite normal. It is evident that the viscosity of the medium has increased under the influence of the acidity, so that a limiting force has to be exerted to allow the creep to proceed. A similar phenomenon was observed with K_2SO_4 but not so regularly.

Baurmann (1924) showed that between P*h*3 and P*h*2 a precipitate fall in the volume of the vitreous occurs; this change is accompanied by the precipitation of the mucoprotein in the gel (Goedbloed, 1934, 2). If it is assumed that the volume change is due to the collapse of the vitreous structure, as opposed to a semi-reversible dehydration, then at P*h*3 the undermining of the vitreous structure would be expected to have already begun, and hence the changes in the elasticity could be put down to this cause. The decreased stability of the vitreous, which would tend to lower the elasticity, would at the same time increase the viscosity of the intermicellar fluid and the two effects would compensate each other to varying extents. If this is true, the irregularities in the shapes of the curves obtained by treating vitreous with KCNS, K_2SO_4, and dilute HCl mentioned earlier are explained, as it is only to be expected that a body in a state of very unstable equilibrium will respond extravagantly to minute changes in its environment, thus prejudicing the reproductibility of results obtained on it.

In view of the results obtained on the extension-time curves, it was important to see whether the absolute values for the extension of a given particle varied greatly according as the vitreous was treated with K_2SO_4, KCNS, or dilute HCl. The only way of achieving this end was to treat a large number of pieces of vitreous successively and analyse the results statistically.

TABLE I

Solution	$\bar{d}$	n	s	t	P
0·5 M KCNS -	+4·34	13	2·56	3·3	<0·01
0·5 M K_2SO_4 -	−1·10	12	4·21	0·9	0·3 − 0·4
$1 \cdot 10^{-3}$M HCl -	−2·30	13	2·53	3·3	<0·01

TABLE II

Protein solution added	Change in stability	
	Setting time	Melting time
1 per cent. ovalbumen - -	——	+
0·5 per cent. agar-agar - -	——	+
2·0 per cent. agar-agar - -	+ + +	+ + +
1·0 per cent. serum globulin -	+	—
0·75 per cent. isinglass - -	——	+ +
1·5 per cent. isinglass - -	——	+ +
2·0 per cent. caseinogen - -	— —	— —

In Table I d is the mean difference in extension for normal and treated vitreous; a positive value means that the treated vitreous gave a larger extension than its control, and hence was less elastic. n is the number of pairs of determinations, s is the standard deviation of the differences, t is the ratio of the mean difference to its standard error (Fisher, 1928), and P is the probability that such a value of t will occur by chance. When P is greater than 0·05 the difference is insignificant. It appears that in 0·5 M KCNS the extension is greater, in dilute HCl less than the control, whilst the difference with K_2SO_4 is insignificant. Here again the results are more in conformity with the supposition that the vitreous stability has been upset than that a reversible syneresis has occurred, or in the case of KCNS a reversible hydration.

As the large volume decrease of the vitreous body on treatment with dilute HCl appeared to be correlated with the precipitation of its muco-protein (Goedbloed, 1934, 2), it was decided to determine in what way the presence of a second protein influenced the stability of a protein clot. In Table II the changes in the stability of gelatin clots by the addition of a second protein as measured by changes in their setting and melting times are shown. Positive signs indicate degrees of increased stability. It is evident from the table that a second protein, or in the case of agar-agar a carbohydrate, may enter into the intimate structure of a gelatine gel. Hitherto, in the vitreous body, the residual protein has been considered as the determining factor in its degree of hydration. The results of this section lead to the view that the vitreous stability and hydration are bound up with the physical states not only

of the residual protein, but also of the muco-protein and perhaps of the albumen and globulin.

In so far as they show that the effects of acid, KCNS, and K_2SO_4 tend to lower the stability of the vitreous body, the results of this section also point to the vitreous body having been formed as a clot from an aqueous solution of proteins, since gels formed by a swelling process alone exhibit a certain degree of reversibility in their hydration and dehydration phenomena. When, furthermore, the similarity in the elastic and ultra-microscopic properties of the vitreous body and dilute plasma clots is considered (Robertson and Duke-Elder, 1933, 2) the balance of evidence points to the vitreous body having been formed as a clot. Hence the second of the two assumptions implied in earlier experiments on the vitreous body, to wit, that this body represents a stage in a continuous process of swelling from an initial xerogel, is shown to be unsound, so that further experiments of the nature of those of Löbeck, and those described in Part I are not likely to yield interesting results. If the theory of a swelling of the vitreous body is still to be maintained it must be on the basis of the alternative theory of a cyclical mechanism outlined earlier.

Section 3. *Attempts at peptisation of the residual protein.* The vitreous body was submitted to ultra-sonic vibrations, as a class of gels, the thixotropic gels, are converted to their sol form by this treatment. No liquefaction of the vitreous body was obtained in this manner. Solutions of KCNS of strengths varying from 0·5 M to a saturated solution, a variety of soaps, and thiourea, in the hot and the cold, were tried on the separated residual protein without any evidence of peptisation. Mörner's treatment (1894) by which the protein was heated with water at 105° under pressure gave a clear solution, which, however, failed to set on cooling as described by this author. Repeated attempts using this treatment failed to give a jelly, and it must be concluded that this vigorous treatment gave breakdown products.

The failure to peptise the vitreous proteins must not be interpreted as vitiating the second theory of vitreous swelling, as post-mortem changes in the ultra-microscopic picture of the vitreous body have been described (Duke-Elder, 1929)* which may be interpreted as being due to denaturation changes. Attention should be drawn here to the statement by Goedbloed (1934, 1) that KCNS, in concentrations of 2·5 M and greater, causes a complete solution of the vitreous body *in vitro*. Such is not the case; we have observed repeatedly that, whilst at 2 M concentration and greater there is a decrease in the volume of the vitreous body culminating at a concentration of 2·5 M in its shrinkage to a minute fraction of its

* Baurmann (1932) denies the existence of these changes.

original volume, the effect is not one of dissolution but one of dehydration as the residual protein is to be seen invariably floating on the top of the solution. We may add that the context of Goedbloed's statement leaves no doubt that it was his intention to convey the idea that the residual protein had completely dissolved.

The same author (1934, 1, 2) denies that the vitreous body is a gel on the grounds that the phenomena associated with it are not reversible. We have some difficulty in taking this criticism seriously, but feel that a reply is necessary to prevent the introduction of confusion into a matter already obscure enough. Firstly we must point out that the exclusion of the vitreous body from the category of gels, on the count of the irreversibility of the phenomena associated with it, simultaneously rules out practically all substances up to now considered as belonging to this class. Secondly, the elasticity as exhibited in the nickel particle technique (Duke-Elder and Robertson, 1933) and the behaviour with ultrasonic vibrations and Hg, the vapour pressure isotherm (Duke-Elder, 1930), the anisotropy (*ibid.*), the formation of Liesegang rings (*ibid.*), and the ultra-microscopic appearances of the vitreous body represent a nexus of properties peculiar to gels. Goedbloed's attempt to discount the evidence of the elasticity of the vitreous body by ascribing this property to its 'framework' as distinguished from it itself is equivalent to denying mass to a piece of iron because the mass belongs to the constituent atoms in its lattice structure.

In conclusion, it must be admitted that the theory that a swelling of the vitreous body is a factor in chronic glaucoma is definitely weakened by the results described in this paper. The changes in volume with *Ph* recorded earlier (Baurmann, 1924; Duke-Elder, 1930; Goedbloed, 1934, 2) which were regarded as evidence for a possible hydration of the vitreous body under suitable conditions *in vivo* (Duke-Elder, 1930) find a new interpretation, in that they do not represent semi-reversible changes similar to those of swollen gelatin, but are to be attributed to varying states of instability produced by the changed *Ph*. The elucidation of the probable mode of origin of the vitreous body has shown the faultiness of certain implied assumptions as to the mechanism whereby the vitreous body could swell; although an alternative mechanism, reasonable from a physico-chemical point of view, has been put forward, it must be pointed out that the hypotheses involved are more numerous and less capable of experimental verification. If the actual peptisation of the vitreous proteins could be achieved, a basis for the experimental verification of this alternative theory would be obtained.

Summary

The chemical and physical properties and behaviour of the vitreous body have been studied with a view to testing the theory that a swelling of the vitreous body is the cause of the raised intra-ocular pressure in primary chronic glaucoma.

No increase in volume of hydration was obtained on treatment of the vitreous body with solutions of sodium oleate and laurate, or by changing the *Ph* to the alkaline side of normality.

The changes in the elastic properties of the vitreous body on treatment with K_2SO_4, KCNS, and dilute HCl indicate that a decreased stability of the gel structure is produced by these reagents.

Attempts at peptisation of the vitreous proteins were unsuccessful.

The theoretical implications in the theory of vitreous swelling are discussed, and a mechanism whereby it may occur put forward.

Goedbloed's denial of the gel nature of the vitreous body is repudiated.

We wish to record our indebtedness to the Medical Research Council for defraying the whole expenses of this research and for a personal grant to one of us (H. D.).

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SOME REMARKS ON THE RECESSION OPERATION FOR SQUINT

BY

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Introduction. In this paper I shall endeavour to show the value of the operation of recession of the internal rectus for convergent concomitant squint. The question is discussed entirely from the operative side. A short description of a simple technique for recession is given, and the results of a series of fifty cases is compared with a number of cases operated upon at the Royal Westminster Ophthalmic Hospital by other methods, and by several surgeons.

Statistical

Only cases are included in which the operation under consideration was the first to be performed on the particular patient.

Between 1929 and 1932, among other operations for squint, there were performed :—

Combined tenotomy and advancement ...	221 cases
Advancement	32 cases
Free tenotomy	28 cases

Owing to insufficient data of 40 cases of the combined operations these have been excluded, and the free tenotomy cases are separated into divergent cases and convergent cases, because the results are very different. We have, therefore, for consideration :—

Combined tenotomy and advancement ...	181 cases
Advancement	32 cases
Tenotomy (for convergent strabismus) ...	16 cases
Tenotomy (for divergent strabismus) ...	12 cases

and the results are shown in the following table :—

TABLE I

Operation	Total cases	Straight	Not straight	Percentage	Average angle of reduction
Combined tenotomy and advancement -	181	99	82	54·7 %	23°
Advancement - -	32	9	23	28 %	10°
Free tenotomy C. -	16	4	12	25 %	10°
Free tenotomy D. -	12	10	2	83·3 %	15°

In compiling these figures I have regarded 5° of squint as cosmetically straight. The angles of squint were taken from the notes of each case. (In the recession series given below all angles were measured on the synoptophore).

From this table several interesting points can be noted. First, in the combined operation, only 54·7 per cent. were straight, which means that 45·3 per cent. required a further operation. Second, advancement by itself has little hope of success, and third, a free tenotomy for *divergent* squint appears to be very satisfactory. Admittedly the last two observations are based on very few cases, but it will not be out of place here to discuss these points more fully.

Consider an advancement as an original operation. This, to my mind, is a thoroughly unsound procedure. The muscle to be advanced is nearly always a thin weak band, with its fibres stretched, a contrast to its antagonist, which is usually a hypertrophied fleshy muscle. In the operation of advancement this attenuated muscle is detached from its insertion and re-attached further forward. Instead of tending to rotate the eye towards itself, and thereby correct the squint, it seems to me more likely that the muscle will stretch still further, and the eye remain convergent. Furthermore, in this operation, acting against the advanced muscle is its powerful antagonist, tending all the time to minimize the effects of the operation. It is not surprising to me, therefore, that there is a low percentage of successful results, and that the average angle of reduction is only 10°.

With regard to free tenotomy; these figures are too small to be of any value at all, but all we learn is that in divergent squint there is a good chance of success. I think most ophthalmic surgeons have now given up a free tenotomy only, for convergent squint.

I have not yet had the opportunity of doing a recession in a divergent squint, but theoretically it is a better surgical operation than a free tenotomy. In a recession, the muscle is re-attached exactly where the surgeon wishes, and he can control the amount done. In a tenotomy, however, there is no knowing what will happen to the muscle in any given case, and there is no control over the angle of reduction. If the surgeon prefers tenotomy to recession, therefore, he should do a guarded tenotomy with a retaining suture, and I do not claim that a recession is any better than this.

In the following table are shown the results of my series of 50 recession operations performed between 1932 and 1934.

TABLE OF RECESSION OPERATIONS

	Case			Date of operation	Type and angle of squint	Operation	Immediate result	Late result	Remarks
1	J.S.	12	F.	Aug., 1934	L.C.C.S. 25°	Lt. recession	Straight	Straight 9 months later	
2	H.D.	13	M.	Mar., 1933	R.C.C.S. 25°	Rt. ,,	Straight	Straight 1 year later	Amblyopic, 5° conv.
3	J.T.	12	M.	Mar., 1933	R.C.C.S. 20°	Rt. ,,	Straight	Straight 2 years later	Slight tendency to diverge
4	E.K.	7	M.	May, 1933	Alt. C.C.S. 25°	Rt. ,,	Straight	Straight 2 years later	No glasses
5	A.L.	6	M	Mar., 1933	Alt. C.C.S. 35°	Rt. ,,	20° conv.	15° conv. after 2 years	For further operation
6	P.D.	13	F.	Aug., 1933	L.C.C.S. 30°	Lt. ,,	15° conv.	Straight 18 months later with glasses	L.C.C.S. 10° without glasses
7	K.M.	10	M.	Sept., 1933	Alt. C.C.S. 30°	Rt. ,,	15° conv.	10° conv. after 1 year	
8	H.P.	12	M.	Oct., 1933	R.C.C.S. 25°	Rt. ,,	Straight	Straight after 18 months	Amblyopic
9	M.M.	14	F.	Dec., 1934	L.C.C.S. 35°	Lt. ,,	20° conv.	Straight 4 months later with glasses	Amblyopic
10	B.B.	12	M.	Aug., 1933	R.C.C.S. 45°	Rt. ,,	20° conv.	20° conv.	Rt. advancement at end of 1933. Straight 1935
11	L.B.	10	F.	Nov., 1934	R.C.C.S. 25°	Rt. ,,	Straight	Straight after 4 months	
12	D.S.	10	M.	Oct., 1933	Alt. C.C.S. 45°	Lt. ,,	35° conv.	35° conv. after 8 months	Lt. advancement and Rt. recession done subsequently
13	P.W.	10	F.	Jan., 1934	Alt. C.C.S. 20°	Rt. ,,	Straight	Straight after 1 year	No glasses
14	K.W.	11	M.	Mar., 1934	R.C.C.S. 20°	Rt. ,,	5° conv.	Straight with glasses after 1 year	R.C.C.S. 10° without glasses
15	B.T.	13	M.	May, 1934	R.C.C.S. 25°	Rt. ,,	5° conv.	Straight after 10 months	
16	J.S.	12	F.	Sept., 1934	L.C.C.S. 25°	Lt. ,,	7° conv.	Straight 7 months later	Amblyopic
17	F.P.	11	F	Sept., 1934	Alt. C.C.S. 20°	Lt. ,,	10° conv.	Straight 5 months later with glasses	Lt. 10° conv. without glasses
18	T.M.	9	M.	Oct., 1933	Alt. C.C.S. 45°	Rt. ,,	30° conv.	30° conv.	Straight, 1935, after Lt. recession in Feb., 1934
19	R.M.	8	M.	Nov., 1934	Alt. C.C.S. 20°	Lt. ,,	10° conv.	10° conv. 6 months later	
20	P.G.	10	M.	Sept., 1933	R.C.C.S. 25°	Rt. ,,	Straight	Straight 18 months later	5° conv. without glasses
21	S.B.	13	M.	June, 1933	Alt. C.C.S. 25°	Rt. ,,	Straight	Straight 20 months later	
22	J.F.	7	M.	Mar., 1934	Alt. C.C.S. 25°	Lt. ,,	15° conv.	15° conv. after 3 months	Straight after Rt. recession
23	W.G.	28	M.	April, 1934	L.C.C.S. 45°	Lt. ,,	15° conv.	Straight	
24	B.K.	15	F.	Sept., 1934	R.C.C.S. 15°	Rt. ,,	Straight	Straight after 6 months	High hypermetrope
25	F.K.	26	F.	Sept., 1934	L.C.C.S. 25°	Lt. ,,	Straight	Straight after 6 months	Amblyopic
26	G.N.	8	F.	Oct., 1934	R.C.C.S. 20°	Rt. ,,	Straight	Straight after 6 months	

TABLE OF RECESSION OPERATIONS *(continued)*

	Case	Date of operation	Type and angle of squint	Operation	Immediate result	Late result	Remarks
27	M.W. 16 F.	June, 1933	L.C.C..S 45°	Lt. recession	10° conv.	Straight after 6 months	Still straight 18 months later. Amblyopic.
28	E.H. 33 F.	Aug., 1933	Alt. C.C.S. 35°	Rt. ,,	20° conv.		After advancement straight
29	A.L. 23 M.	Jan., 1933	R.C.C.S. 15°	Rt. ,,	Straight	Straight after 2 years	
30	L.G. 16 F.	Jan., 1933	L.C.C.S. 60°	Lt. ,,	40° conv.		After advancement straight, myope
31	E.T. 7 M.	Oct., 1934	L.C.C.S. 35°	Lt. ,,	10° conv.		
32	R.W. 14 F.	Sept., 1932	R.C.C.S. 30°	Rt. ,,	Straight	Straight 2½ years later	No glasses
33	M.F. 10 F.	Nov., 1934	R.C.C.S. 40°	Rt. ,,	Straight	Straight after 6 months	
34	P.D. 8 F.	Oct., 1934	L.C.C.S. 20°	Lt. ,,	Straight	Straight after 6 months	
35	M.D. 10 F.	Aug., 1934	R.C.C.S. 40°	Rt. ,,	Straight	Straight after 9 months with glasses	10° conv. without glasses
36	D.J. 9 F.	May, 1934	L.C.C.S. 35°	Lt. ,,	Straight	Straight after 1 year with glasses	10° conv. without glasses
37	J.H. 6 F.	April, 1934	Alt. C.C.S. 40°	Lt. ,,	Straight	Straight after 1 year with glasses	5°-10° conv. without glasses, high hypermetrope
38	M.G. 20 F.	Jan., 1934	R.C.C.S. 40°	Rt. ,,	15° conv.	Straight after 1 year	Amblyopic
39	W.P. 22 M.	Oct., 1933	L.C.C.S. 30°	Lt. ,,	Straight	Straight after 18 months	
40	A.W. 23 F.	June, 1933	L.C.C.S. 30°	Lt. ,,	15° conv.	Straight after 21 months	Amblyopic. No glasses
41	R.M. 7 M.	Jan., 1933	Alt. C.C.S. 45°	Rt. ,,	20° conv.	I.S.Q.	Advancement later
42	R.L. 12 M.	Aug., 1933	Alt. C.C.S. 40°	Rt. ,,	20° conv.	I.S.Q.	Advancement later
43	C.W. 9 M.	Aug., 1933	R.C.C.S. 35°	Rt. ,,	Straight	Straight after 1 year	10° conv. without glasses
44	G.W. 8 F.	Aug., 1934	L.C.C.S.	Lt. ,,	Straight	Straight after 9 months	
45	D.I. 13 F.	Aug., 1932	L.C.C.S. 35°	Lt. ,,	10° conv.	10° conv. 2½ years later	
46	W.P. 13 M.	Aug., 1932	Alt. C.C.S. 40°	Lt. ,,	Straight	Straight 2½ years later	
47	D.M. 13 M.	Sept., 1932	L.C.C.S.	Lt. ,,	Converges	Straight 2½ years later with glasses	
48	S.W. 10 M.	Aug., 1934	R.C.C.S. 15°	Rt. ,,	Straight	Straight 9 months later	
49	W.S. 14 F.	Mar., 1932	R.C.C.S.	Rt. ,,	Straight	Straight 3 years later with glasses	Angle not known
50	J.D. 15 M.	Aug., 1934	Alt. C.C.S. 30°	Lt. ,,	Straight	Straight 18 months later with glasses	10° conv. without glasses

It will be seen that:—

1. 37 cases or 74 per cent. were cosmetically straight (here again 5° convergence is regarded as straight) after periods varying from 3 months to 3 years.

2. 10 cases were straight only with glasses, converging about 10° without glasses.

3. The average angle of reduction was 24°.

4. Of the 13 cases not straight, 9 were alternating, and of these 9 the original angle of squint was 30° or more, in 7.

5. Cases 6, 7, 9, 17, 23, 27, 38, 40, immediately after operation were convergent 10° or more, but that all these became less convergent later. (It should be made clear that the immediate result means the result at the time of the patient's discharge from hospital, ten days after the operation).

Comments

It seems justifiable to assert that the recession operation compares favourably with a combined tenotomy and advancement. The angle of reduction in the two tables is the same. In Table I the angles were taken from the notes, and were not all measured accurately. In Table II the angles were measured on the synoptophore. Any discrepancy here is, I think, in favour of the recession, because the tendency is to over-estimate angles of squint if they are judged by looking at them. The percentage of successful results is much better with the recession (74 per cent. compared with 54·7 per cent.) but these figures are perhaps misleading owing to the difference in totals. In the recession operation only one muscle is disturbed, and this is surely an advantage.

I want now to refer to some criticisms of this operation.

First, it has been suggested that it is a dangerous operation because the sclera is so thin at the equator, and the eyeball is likely to be perforated by the needle. I am sure that there is no need for this accident; the sclera is admittedly very thin, but as there will be no tension on the sutures, it is not necessary to take a very firm grip, only a few scleral fibres need be picked up on the needle.

Second, in some cases results have not been good, and this I believe to be due to the fact that the muscle has not been recessed far enough back. I have on a few occasions seen the operation done and the muscle only moved 2 or 3 millimetres.

Third, it has been said that if the muscle is recessed to, or beyond, the equator, convergence is interfered with. I have not met this complication, and upon enquiry of the orthoptic department I have heard no instance of it.

Fourth, there is the obvious criticism that divergence is likely to occur after several years, as was seen in free tenotomies. My

own experience only goes back a few years, but I have only seen one case (case 3 of my series) in which there is now a slight tendency to divergence. Foster Moore, who started doing recession operations about 8 years ago, kindly sent me a personal communication in which he says that he can recall no case of this sequela.

Fifth, sinking in of the caruncle has been described as a late complication of this operation. I can only say I have never seen it.

Recession Operation

The angle of squint is measured on the synoptophore previous to operation. If the patient is a child, evipan anaesthesia is used. This is a very satisfactory anaesthetic, and causes the minimum discomfort both to the patient and also to the surgeon, who is not hampered in any way by anaesthetic apparatus. (The reader should consult the paper by Lyle and Fenton on Evipan Anaesthesia in Ophthalmic Surgery).

The Operation. The speculum is inserted and a vertical incision made through the conjunctiva about 3 mm. from the limbus. The conjunctiva is separated towards the plica, and it is a good plan at this stage to insert a silk stitch into the conjunctival flap on the inner side (plica) as this flap is sometimes difficult to find at the end of the operation, and also the silk can be used to retract the flap; a less damaging method than by forceps.

In freeing the conjunctiva care must be taken not to open the rectus sheath, otherwise there may be troublesome bleeding, or the raw surface so produced may form adhesions with the under surface of the conjunctiva, and so minimize the extent of the recession. A squint hook is passed under the rectus muscle, which is isolated, and the hook is then replaced by a Prince's forceps. I prefer the forceps with a sliding catch, and three teeth on one blade. The forceps is applied about 2 mm. from the insertion of the muscle to the globe, and the muscle is next freed from its scleral insertion by cutting with scissors on the limbal side of the forceps, flush with the blade. Thus a small stump of tendinous insertion is left attached to the sclera, and this is used at a later stage for rotating the globe.

Before inserting sutures the operator must be certain that the muscle is quite free from its surroundings. Very often one finds bands of insertion to the sclera further back on the under surface of the muscle, and others on the upper surface of the muscle finding attachment to the under surface of the plica. These must all be divided.

For the sutures 000000 catgut is used. The needle used is an ordinary curved squint needle (split-eye). The sutures are inserted as shown in Fig. 1. The needle is passed from front to back of

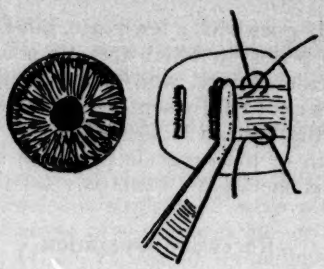

FIG. 1.

Sutures inserted through muscle, behind Prince's forceps.

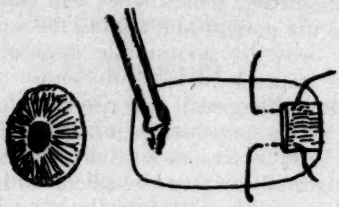

FIG. 2.

Sutures inserted through muscle and sclera.

the upper border of the muscle and passes again from front to back. A similar suture is inserted at the lower border of the muscle. The forceps is now removed. The globe is well rotated, a good grip being obtained by toothed forceps applied to the stump of original insertion.

The muscle is now re-attached to the sclera, the amount of recession depending on the angle of squint. The sclera is exceedingly thin in the region of the equator, so that care must be taken to avoid piercing it with the needle point. As there is no tension on the sutures, a firm grip is not necessary, consequently only a few scleral fibres need be picked up on the needle. The sutures are inserted in a line with the original insertion, and about 8 mm. apart, so as to keep the muscle band flat. Finally the sutures are tied and cut short. The conjunctival incision is closed with two or three silk sutures. The catgut sutures are thus buried, and left to absorb, while the conjunctival sutures are removed in a week.

Post-operative. Both eyes are bandaged, and the child kept in bed for one week. At the end of this time the bandages are removed and the child gets up. Glasses are worn immediately, unless there is no refractive error. Twenty-four hours after operation the eyes are irrigated, and this is done once daily unless there is any necessity for more frequent treatment. The immediate post-operative result is not final. It may be some weeks before

the end result is obtained. In cases, therefore, in which one recession is not enough to bring the eyes straight, I prefer to wait some weeks before doing a second operation.

When a second operation is necessary, either an advancement of the external rectus of the same eye, or a recession of the internal rectus of the other eye, is done. In this series four cases have had recession followed by advancement, and three of these were straight; the other had to have, as well, a recession on the other eye (Case 12). Two have had recession on each side, and these are straight. I am inclined to think that in an amblyopic eye it is better to do the second operation on this eye, and leave the good eye alone, but in an alternating squint a recession on both may be done.

With regard to the amount of recession, I do not believe it is worth while trying to work out how many millimetres of recession are equivalent to degrees of squint. Each case varies to some extent, and in any event, as is seen from several of the cases in Table II, the end result is not the same as the immediate result.

From Table II we see that the amount expected of a recession is about 25°, and in a squint of this size I endeavour to recess as far back as the equator; if the squint is more than 25°, I try and recess a little further back still, but usually the equator is as far as can conveniently be managed. If the squint is less than 25°, say 15°, then the muscle should be re-inserted just in front of the equator. It is useless to recess 2 or 3 millimetres. In fact, if we remember that 1 millimetre is left at the insertion, 2 millimetres are taken up by the forceps, (and we insert our stitches just behind this) and then we "recess" 3 millimetres, we are really re-attaching the muscle exactly where that part of it originally lay in contact with the sclera, and the result of the operation is nothing.

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EXPERIENCES WITH GLAUCOSAN

BY

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THE French Ophthalmologist Darier was the first to make the experiment (1896) of utilizing the hormone of the suprarenal gland for the purposes of ophthalmology.

His most important discovery, subsequently confirmed by general observations, was an enlargement of the pupil (sympathetic excitation) while reducing the eye pressure. Not until 20-30

years later was this medicament applied generally to the human body in the form of subconjunctival injections, more especially for the purpose of rupturing posterior synechiae. Success was obtained in severing synechiae, which had withstood all other mydriatics.

Undesired effects, such as increase of blood pressure which had been frequently observed when applying adrenalin and suprarenin, led to glaucosan being introduced, which is named according to its composition as dextro- or laevo-glaucosan.

The preparation designated dextro-glaucosan consisting of suprarenin of right-hand rotation, with an optically inactive preliminary stage, leaves the blood pressure unaffected and acts solely locally, although subconjunctival injection is necessary when applying it. Not until success had been reached by means of laevo-glaucosan (glaucosan drops) *i.e.*, a combination of *left-hand* rotating suprarenin with an optically inactive preliminary stage (thus substituting by *drops* the inconvenient injection) was the method keenly discussed in ophthalmological circles in all countries of culture, and not the least important physicians to gain merit in the expansion of the method are the Americans: Gifford of Omaha; Kasp. Pischel of San Francisco and others.

The application of this preparation is due above all to its incomparable pupil-enlarging effect while at the same time reducing the pressure (emollient). It is, therefore, particularly valuable for severe iritis, providing the iris-lens coalescence is not too long established. Although it does not render atropine and scopolamine indispensable, (which, previously, frequently had to be given up to symptoms of intoxication) it exceeds them appreciably in effect. The effect obtained, that is, the dilatation of the pupil, is preferably maintained by atropine or scopolamine because the effect of glaucosan will only persist for a few hours. Where a drop (laevo-glaucosan) is insufficient to get a wide enough pupil, the organ is massaged near the limbus corneae according to the proposal of Grad (Prague) at the particular spot with a fine, wadding-covered probe for about 10 seconds. The high pupillo-motor force is shown in particularly clear manner by a perforating, central injury with inclusion of the iris; the medicament drew the iris completely out of the wound. Also a secondary cataract operation became unnecessary, because the coalescence between lens capsule and iris was ruptured.

Furthermore, secondary glaucoma is an important therapeutic object in glaucosan treatment. Operative intervention will here frequently entail the danger, in view of the atrophic condition of the iris, that the iris forceps might pull away a piece of the lens capsule; the operation may therefore readily lead to opacity of the lens, that is, to grey cataract, a very annoying complication

with glaucoma (with its shallow anterior chamber). It is, therefore, of the utmost importance to possess a medium which will frequently permit, by a severing of synechiae, of dispensing with operation. "In secondary glaucoma glaucosan will succeed in rupturing synechiae, which with other mydriatics remain unaffected." (*Brit. Med. Jl.*, March 30, 1929, pp. 590-2).

Glaucosan drops should be *just as indispensable* in iritis glaucomatosa. Here is indicated; on the one hand an enlargement of the pupil; on the other hand a reduction of the eye pressure. This double effect: mollification and mydriasis is accomplished by no other medicament, only laevo-glaucosan will perform it! Atropine is contraindicated, as it enhances the pressure (nor does it come up to the powerful dilating force of glaucosan) and miotics are contraindicated, because they will increase through inflammation iris-lens agglutination. The verdict is therefore right: "Glaucosan has up to the present remained unexcelled in its effect upon the iris, where synechiae require to be ruptured." This property will secure a firm position for glaucosan drops in ophthalmology, because it helps to avoid the great danger which extensive or even annular iris-lens synechiae mean to the eye for the duration of life.

Let us emphasize yet one indication particularly: the test as to whether optical iridectomy offers any prospects for extensive opacity of the cornea. According to the proposal of Vannas (Helsingfors), the pupil is enlarged eccentrically where the optical coloboma is to be applied in a circumscribed place: by means of a wadding-covered probe but slightly moistened with glaucosan the conjunctiva is massaged at the circumscribed place of the limbus. None of the glaucosan must flow into the conjunctival sac, otherwise instead of an eccentric a concentric mydriasis would arise.

In glaucoma simplex, this most pernicious and varied form of glaucoma, glaucosan is capable, in cases where eserine and pilocarpine remain ineffective, of bringing about an appreciable reduction of pressure and to sensitize the eye in such a way that miotics again become effective. A trial should therefore be made with glaucosan in suitable cases where miotics fail, prior to operative intervention, viz.: not drops the first time but according to Vannas's proposal "massage," so tenderly that the pupil will yield but little, owing to the danger of subsequent increase of pressure. If the "circumscribed massage" has been well stood, one drop should be given according to Gifford's suggestion to the eserined eye. The pupil it to be enlarged only half wide.

After ½ hour, at latest, apply miotics, frequently, in intervals of 15 to 20 minutes; the pupil has to become narrow again and to remain so. All this is preferably carried out in the forenoon, with

a view to apply observation; for the first time in a clinic, if possible. If the pressure drops adequately, it may be left at *one* drop, otherwise two drops may be allowed, this being repeated if necessary two or three times at intervals of a quarter of an hour. Gifford emphasizes particularly that he does not desire to discourage by mentioning the occasional increase of the pressure. Although it cannot be determined definitely which glaucoma simplex eyes will react by increased pressure, nevertheless it may be maintained from experience that it is primarily eyes of a T. of 40 mm. and above which have such a propensity*).

A further very important question is: *What happens if the operation was unsuccessful?* This is unfortunately very often the case; even with acute glaucoma the pressure not infrequently rises again, but more especially after the operation of glaucoma simplex. Should the anxious patients, mostly of considerable age, now immediately be confronted by a further operative intervention? It is better when vision declines in such cases first of all to make a trial with glaucosan drops. Huber (Glarus, Switzerland) writes: "As it was throughout a question of cases where all other therapy had failed, the three cures are after all remarkable."

Professor Hegner (Lucerne, Switzerland) has communicated two gratifying results on unsuccessfully operated eyes. *To this should be added that acute attacks on operated eyes are rare.* "If the operations fail, adrenalin is able to reduce the pressure to normal." (Ungerer, Marseille. Sur le traitement du glaucoma par l'adrenaline, 1928). First of all the application of glaucosan should here also take place with every caution, as on an untouched eye, but thereafter more frequently and regularly—once or twice a week; many clinicians apply glaucosan drops in fact up to twice daily in unsuccessfully operated cases, invariably alternately with miotics. There is no doubt that many an operated glaucoma eye is in this manner spared another operation for months and years; and after all it is mostly a matter of people of advanced age.

Quite definitely glaucosan drops will not render operations superfluous; the operation may frequently represent a real delivery. But the criticism of Ungerer should be recalled to mind who in his aforementioned work surveys this treatment in detail; also the words of Darier (Clinique ophtalmologique, 1926, Nr. 6,

* Jess, chief of the eye-clinic, University of Leipzig, writes (*Medicin. Welt.*, No. 26, 1931): "it is undoubtedly the merit of Hamburger to have, by systematical ever renewed experiences, considerably enriched the medicamental treatment of glaucoma. If we have in glaucosan no panacea for glaucoma—as Hamburger admits himself—one must however say, that in many cases of glaucoma simplex, when eserine and pilocarpine proved inefficient, glaucosan produced a considerable decline of tension; moreover, after application of glaucosan, miotics proved more efficient than before. It is not to be concealed however, that here and there unexpected increase of pressure leads to serious complications. In most cases one can speedily do away with them by an intravenous injection of 10 c.cm. of a 10 per cent. Na Cl-Solution (introduced by Hertel)."

1927, Nr. 5), according to which this treatment is worthy of every consideration; similarly the criticism of Gifford, according to which the value of the method is considerable and definite.

This applies in our opinion above all—(1) to iritis glaumatosa, and (2) to glaucoma cases unsuccessfully operated on or with but transitory success.

A KNIFE FOR CORNEAL GRAFTING

BY

H. B. STALLARD

LONDON

AN essential part of the modern technique of corneal grafting is the cutting of a shelf through the deeper layers of the cornea in order to prevent the graft from slipping into the anterior chamber of the recipient's eye. It is desirable that as far as possible the shelving of the donor's graft and the corneal bed of the recipient should correspond.

Tudor Thomas uses scissors to cut this shelf after the trephine has entered the anterior chamber. However skilful the operator these cuts with the scissors are at the best rough and irregular and the adjacent tissues are crushed and mutilated to some extent.

On this account I felt prompted to design and try a small corneal knife, a diagram of which is shown below.

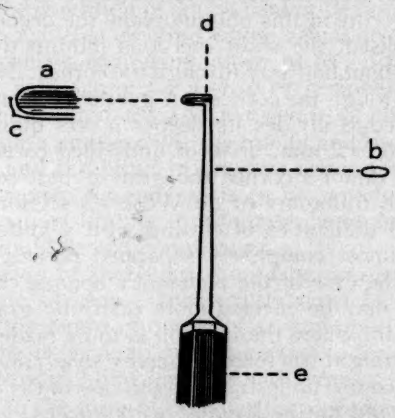

DIAGRAM OF CORNEAL KNIFE

(a) Magnified view of the knife blade. The cutting edge is 1·5 mm. long and is continued half way round the curved extremity of the knife, shown in the diagram by the bracket (c). (b) Is the shaft, which in section is a flat oval. (d) The edge (d) is rounded and smooth. (e) Bakelite handle.

A small blade 1·5 mm. long and 1 mm. deep is set at right angles to the shaft which is a flat oval in section and fixed into a bakelite handle. The cutting edge is on the upper side of the knife and the upper half of the rounded extremity is sharpened. The remainder is rounded and smooth.

The knife has been tried on a few animals' eyes and in one case on the human. The technique adopted in the latter case was briefly as follows. The recipient's eye was anaesthetized with pantocain and the subconjunctival tissues injected with novocain. The conjunctiva was incised all round the limbus and undermined to an extent necessary to draw a complete conjunctival flap over the cornea and the graft. A purse-string suture was threaded 2 mm. distal to the cut margin of the conjunctiva and at the end of the operation drawn together and tied.

In cutting the graft and preparing its bed in the recipient's eye half the corneal thickness was cut cleanly through at right angles to the surface by giving a few sharp turns to the trephine. The trephine was then tilted towards the nasal side and approximately one-third of the circumference cut through in a shelving manner into the anterior chamber. The corneal knife was then passed through the trephine incision into the anterior chamber on the flat and gently turned into a position where the shaft lay against the undivided part of the cornea and the blade was placed at an oblique angle to cut through its deeper layers from within outwards, the incision on the inner surface of the cornea being nearer its centre than the original trephine cut on the surface. By a series of firm, short, sweeping cuts in this oblique plane the deeper layers of the cornea were incised, the short incisions joining the original trephine incision about half way through the cornea. The knife should not be pulled through the cornea. A gentle but firm sliding action of the cutting edge divides its deeper layers quite satisfactorily until the last 1·5 to 2 mm. or so of undivided cornea remain. In the case of the donor's cornea the graft is best separated by an oblique cut with iridotomy or de Wecker's scissors at this point as the technical difficulties of cutting with a knife so mobile an object as an almost completely separated corneal disc are considerable. In the case of the recipient's opaque corneal disc this final severance may be effected more easily by grasping the disc opposite the point where the incision is to be made with a pair of fine, toothed, straight iris forceps thereby steadying the disc. This procedure is of course undesirable in the case of the donor's corneal graft which should not be handled with forceps.

The imperfections of this technique with the corneal knife are that the incisions through the deeper layers of the cornea are set side by side at a small angle instead of the ideal even curve but where the incisions are so small, probably 1 mm. or less, this seems to be of little practical importance.

It is probable that some better method than this will be devised but it appealed to me as being less likely to cause as much trauma to the deeper parts of the cornea as is the case where scissors are used to effect the necessary shelf.

In the one human case the graft fitted neatly, has taken, and the anterior chamber reformed satisfactorily without adhesion of the iris or lens capsule to the cornea.

ANNOTATIONS

Classification of the Causes of Blindness

An important report on this subject was presented at the General Assembly of the International Association for the Prevention of Blindness in April, 1935, by Professor van Duyse, of Ghent. After a brief review of the schemes in use in such countries as Germany, Belgium, France, Great Britain and the United States, the reporter gave the proposals of his organization which may be summarized as follows:—

It is proposed to consider as socially blind (*a*) any person who is unable to count fingers against a dark background at a distance of one metre, under good lighting conditions, after correction of the refraction, the condition of which cannot be improved. (*b*) Persons are to be considered as blind whose visual fields are seriously impaired; (concentric narrowing down to 5°; disseminated scotomata; loss of field except for a strip or peripheral sector); and persons with night blindness and narrowing of the visual fields.

The classification must include the totally and the socially blind. Curable cases, and the blind in one eye are not to be included. Only the final cause of blindness is to be stated, for if primary and secondary causes leading to blindness be included, the registration forms would be too complicated.

The examination of the blind should be entrusted *exclusively* to an ophthalmic surgeon. Incurability must be recognized on the strength of the report of one or of several ophthalmologists.

The age of the individual is of importance, for the chances of being (not becoming) blind increase with years.

With regard to the form of classification opinions differ: some hold that a detailed classification alone is sufficiently accurate for scientific purposes; others think that an extensive classification would lead to unnecessarily complicated forms which would not commend themselves for general use.

A classification may be based on either pathological anatomy, topography or aetiology. The author of the report considers the brief classification proposed by Bishop Harman to be suitable, and that it might be adopted as it stands.

The committee will feel obliged if their colleagues will address observations and information which they deem useful to the Secrétariate General, 66, Boulevard Saint Michel, Paris.

Professor van Duyse and the members of his committee are to be congratulated upon a notable piece of work.

Intravenous Anaesthesia—Sodium Evipan

From time to time in the practice of medicine there is discovered or revived a therapeutic agent whose usefulness, limited or otherwise, fails to receive its proper recognition owing to the lack of balanced assessment both by its enthusiastic proponents and by those who have condemned it for one reason or another after but a brief preliminary trial.

Recently some interest has been centred round the use of an intravenous anaesthetic, sodium evipan, a chemical relative of the barbiturate compound sodium amytal which a few years ago was proclaimed the ideal anaesthetic and was then abandoned. Sodium evipan has received a trial in ophthalmic surgery. The claims advanced in favour of it are the quiet induction of anaesthesia whilst the patient is in bed; the avoidance of the mental distress provoked by the journey to the theatre, the induction of a general anaesthetic or the strain involved during an operation under local anaesthesia; the quick recovery and the diminution of post-operative vomiting and discomfort. The disadvantages, which are of a variety that would cause very great concern to the ophthalmic surgeon, are reflex sneezing as soon as the conjunctiva is touched with an instrument; paroxysms of coughing and muscular twitchings amounting in some cases to jactitation. Cases have been reported of post-anaesthetic vomiting, sleeplessness, headaches, cardiac weakness with a rapid pulse and extra systole. Nine deaths have been reported in the literature.

The use of sodium evipan is contraindicated in hepatic disease, arteriosclerosis, pulmonary tuberculosis and asthma.

Lyle and Fenton (*Brit. Med. Jl.*, April 13, 1935, p. 763), record the fact that they have used sodium evipan in over 200 ophthalmic operations at the Royal Westminster Ophthalmic Hospital and state that "our previous experience that evipan was an ideal anaesthetic for ophthalmic operations is definitely confirmed. . . . Happily in our whole series of cases we have not experienced the slightest anxiety at any time during the period of narcosis or

subsequently." However, in discussing the "practical points" of evipan anaesthesia they mention the fact that premedication with omnopon and scopolamine diminishes the reflex movements of the patient and the sneezing reflex is less liable to occur. This consistency seems to detract from the strength of their case for the use of sodium evipan in ophthalmology.

Johnstone (*Brit. Med. Jl.*, April 13, 1935, p. 761), states that in his experience premedication caused more unsatisfactory incidents and complications than in cases where this was omitted.

Sneezing can be lessened by using cocaine instillations into the conjunctival sac and some observers allege that muscular twitchings may be diminished and sometimes abolished by increasing the dose but all agree that there are technical difficulties such as jerking the needle out of the vein or failure to enter the vein on account of the uncontrollable and violent movements of the patient.

It would seem that in the uncertainty of action of sodium evipan lies a very real danger. The disasters that may attend any operations on the eye through sneezing, coughing, muscular twitchings and the rise of intra-ocular pressure that these would cause is obvious and at the present it seems unjustifiable to run such risks particularly for intra-ocular operations when such measures as a facial nerve block and the injection of Tenon's capsule with a local anaesthetic, and a suture through the superior rectus may render operation possible even in patients most difficult to control. The main disadvantages which have attended the use of any intravenous anaesthetic up to date are the relative loss of control of the patient as compared with local anaesthesia, the uncertainty of the drug's action in some individuals and in many instances the inability to rectify serious complications when these occur during or after operation.

In the case of sodium evipan it may be said that until its action can be controlled with greater precision and certainty its use as an anaesthetic in ophthalmic surgery is limited.

ALL-INDIA OPHTHALMOLOGICAL SOCIETY

Fourth Conference

THE above Society held its Fourth Conference at Madras on April 22, 23 and 24, 1935. The President Elect was Lt.-Col. R. E. Wright, Professor of Ophthalmology and Superintendent, Govt. Ophthalmic Hospital, Madras. On the first day, Dr. E. V. Srinivasan, on behalf of the Reception Committee, welcomed the

members; the Secretary, Dr. G. Zachariah, next introduced Sir Mahomed Usman, Ex-Acting Governor of Madras, who opened the session with a short address which dealt with the history of the Govt. Ophthalmic Hospital, Madras, and its influence in the spread of Ophthalmology in India, particularly in the direction of post-graduate teaching of recent years. Col. Wright then delivered the Presidential address. In the afternoon a number of papers were read on "Nutritional disorders of the eye." The discussion centred chiefly around keratomalacia or xerophthalmia (these terms being used by speakers as equivalent to the congeries of pathological changes resulting from a polydeficiency in which vitaminosis "A" appears to play a prominent part). This common condition familiar to workers in the East for many years, plays a prominent rôle as a cause of preventible blindness. Contrary to views expressed by recent workers in England and elsewhere, skin rashes were not considered more frequent in keratomalacia than in the general hospital population, with the exception of lichen pilaris. The same applies to pyogenic infections in general. The view was expressed that many laboratory workers were unfamiliar with the well developed human disorder as it occurs in bulk; hence certain divergencies of opinion in recent literature.

On the second day, the sessions were held in the Elliot School theatre of the Govt. Ophthalmic Hospital. An interesting programme of twelve short papers was given by members of the hospital staff on:—Sympathetic ophthalmitis, Occlusion of the central artery, White rings of the cornea, Corneal opacities due to sugar of lead, Corneal ulcer due to Glenospora graphii, Simple xerosis conjunctivae, Tuberculosis conjunctivae, Leptothricosis conjunctivae, von Hippel's disease, Birth injury of the cornea, Clinical aspects of glaucoma, Modern methods of anaesthesia in ophthalmic practice, Rare complications of cataract extraction. The paper on Sympathetic ophthalmitis, read by Dr. K. Koman Nayar, showed that the Govt. Ophthalmic Hospital experience was that this condition was less frequent in Indians than in Europeans. Discussion showed that this was not the universal opinion, Dr. B. K. Narayana Rao (Mysore) was in opposition to the view. Members were enabled to examine the extensive collection of intra-cranial lesion radiographs, water colour pictures and stereo-photos of external diseases of the eye, and the various other exhibits of the museum. A number of clinical cases were demonstrated including a group of 20 patients showing the various manifestations of keratomalacia, patients with acne rosacea, von Hippel's disease, Groenouw's keratitis, xerodermia pigmentosa, thrombosis of the central vein, and two keratoconus cases, the last three by Dr. Narayana Rao. Other papers read were on the rôle of anaesthesia in ophthalmology and three cases of Groenouw's disease. Prevention of blindness was

discussed at the end of the afternoon session following an exhibition of coloured posters and lantern slides prepared for the Association for the Prevention of Blindness, Bengal, by Lt.-Col. E. O'G. Kirwan, Red Cross posters designed in New Delhi, and local Madras posters were also exhibited.

The final session was held in the Library Hall of the Madras Medical College. Papers were presented on:—The importance of the study of the field of vision on the prognosis and treatment of epidemic dropsy glaucoma; detachment of the retina, (26 cases); ocular complications due to focal sepsis; the effects of subconjunctival injections of guaiacol cacodylate in phlyctenular keratoconjunctivitis; asepsis of the conjunctival sac; some observations on slit-lamp microscopy; treatment of immature senile cataract; cataract extraction in Aligarh; blue sclerotics with congenital syphilis; buphthalmos and blue sclerotics; diphtheria of the conjunctiva; unilateral trachoma; a short history of incidence of glaucoma in Bengal; ophthalmoplegic migraine involving VI nerve. The subject of greatest interest was primary non-congestive glaucoma, the Calcutta members bringing forward experience in connection with the recent outbreaks of epidemic dropsy. The fact that in the excessively high tensions of epidemic dropsy glaucoma, field changes and disc changes might be absent for months elicited an interesting discussion. Decompression by sclerocorneal trephining was still employed extensively in Calcutta, hundreds of operations having been done in the last few months.

In connection with the Prevention of Blindness, it was considered by the Committee that the responsibility of governing authorities was insufficiently realized and that certain recommendations should be put before the various authorities in British India and the Indian States. These will appear in due course. About sixty members attended.

ABSTRACTS

MISCELLANEOUS

(1) **Minchin, R. L. Haviland (Indian Military Hospital, Abbottabad).—Blood stained tears.** *Lancet*, January 19, 1935.

(1) Minchin reports the following case. "A girl, 3½ years of age, child of a Gurkha rifleman, was brought to hospital with the history that for the last three months whenever she cried blood and not tears came from the eyes. The child was examined

but no abnormality could be detected in the conjunctiva or lacrymal apparatus; the general health was good and no marked anaemia was present. An iron mixture was prescribed and the parents instructed to bring the child again to hospital should no improvement occur." She was duly brought back, and cried *on examination*, when actual blood, mixed with tears, was observed. The writer remarks that in view of the child's age this case can hardly be one of vicarious menstruation; but he makes no speculation as to the actual cause.

ERNEST THOMSON.

(2) **Jameson, P. Chalmers (Brooklyn).—Vascularization of the anterior segment of the eye.** *Arch. of Ophthal.*, April, 1933.

(2) **Jameson** has found, in performing peritomy for pinguecula, pannus, etc., that the newly formed corneal vessels receive blood from the ciliary as well as from the conjunctival vascular system. If a cure is to be obtained both these must be obliterated. To obliterate the ciliary contributions is not easy, since the minute vessels are covered by a prolongation forwards of Tenon's capsule which protects them from destruction by curettage. They can be dealt with, however, by making a series of parallel incisions down to the sclera with a Graefe knife over the affected area. The result of doing this is to cause blanching of the previously engorged area, and the idea occurred to the author that the procedure might be of use in congestive glaucoma. In one case, after incising and turning back the conjunctiva from the corneal margin, the ciliary reticulum "was thoroughly sectioned by linear incisions 1·5 mm. apart by a von Graefe knife carried through the membrane in an area of about 6 mm. surrounding the limbus." The sclera was white after spooning away clot and the conjunctiva was brought back into position by a purse-string suture. Intra-ocular pressure was reduced from 50 mm. Hg to 35 and the patient was freed of pain. In a second case, the reduction was from 40 mm. Hg to 20, and in a third, the operation was performed in conjunction with a Lagrange operation and produced satisfactory results.

F. A. W-N.

(3) **Lindberg, J. G. (Helsingfors).—Experimental research on the blood pressure in the retinal veins of the rabbit with increased intracranial pressure. (Experimentelle Untersuchungen ueber den Blutdruck in den retinalen Venen des Kaninchens bei erhöhtem Gehirndruck.** *Arch. f. Ophthal.*, Vol. CXXXIII, p. 191.

(3) For this research on the rabbit's eye Lindberg devised an apparatus which was made to adhere to the eyeball by negative pressure, and he employed the pumping of air into the cranial cavity in order to raise the intra-cranial pressure.

He found that the pressure in the retinal veins rises and falls in direct proportion to the changes in pressure artificially produced within the skull. His experiments confirm Barmann's view that the intra-cranial pressure and that in the retinal veins is always the same, as against the results obtained by Bailliart.

Variations in the intra-cranial pressure are followed almost instantaneously by corresponding changes in pressure in the retinal vein; even after the pressure within the skull has been kept raised for a considerable time the pressure in the retinal veins drops almost immediately when the intra-cranial pressure falls, provided the latter is not raised above 40-50 mm. Hg. When the pressure in the cranial cavity is 40 mm. Hg there seems to be practically no difference between the pressure in the retinal arteries and that in the veins, *i.e.*, the circulation in the central vessels at this point is as bad as possible. At this "critical" point signs of papilloedema would, theoretically, be bound to appear. In his experiments, however, no sign of papilloedema was produced even after the intra-cranial pressure was kept at 40 mm. Hg for three hours or raised to 70-80 mm. Hg from which the animals usually succumbed.

When the intra-cranial pressure is raised above 40-50 mm. Hg cerebral anaemia is threatened, and then there is a compensatory increase in the general blood pressure and with it a rise in that of the retinal arteries; a slight rise, however, does not affect these arteries (as it does the veins) even when it is kept up for hours.

THOS. SNOWBALL.

(4) **Giannini (Pisa).—The influence of certain drugs applied to the nasal mucous membrane on the retinal arterial circulation. (Influenza di alcune sostanze farmaco-dinamiche introdotte per via endonasale sulla circolazione arteriosa retinica).** *Ann. di Ottal.*, November, 1934.

(4) The relation of diseased conditions of the nose and adjacent sinuses to disease of the eye has assumed a considerable importance of late years in the opinion of ophthalmologists. Giannini has tried to discover how far drugs applied to the middle turbinate bone on pledgets of cotton wool, have influence on the arterial pressure in the retina. He finds that in many cases there is some alteration of the arterial pressure, though of small degree, a difference so constant that he thinks we may fairly assume it to be the expression of an action, either direct or indirect, of the nasal stimulation. In cases of retro-bulbar neuritis he noticed that cocaine applied to the nose caused a reduction of the retinal arterial pressure and a temporary improvement of vision.

HAROLD GRIMSDALE.

(5) **Magitot, A. (Paris).—Carotid sympathectomy in man and its application in certain affections of the optic nerve and retina. (La sympathectomie carotidienne chez l'homme et ses applications dans certaines affections du nerf optique et de la retina).** *Ann. d'Ocul.*, Vol. CLXXI, p. 897, 1934.

(5) **Magitot** reports in detail six cases in which an operation for the removal of the carotid sympathetic plexus was performed. He goes in detail into the effects on animals and man of this procedure. The sympathetic plexus is removed from the common carotid for about two centimetres and for a similar distance along the internal carotid artery. The arterial wall so cleared is treated with carbolic acid to ensure the destruction of all nerve fibres.

In man it is found that there is a rise of general arterial blood pressure in one in ten, which persists for some months. A high blood pressure is, therefore, a contra-indication to the operation. The Claude Bernard-Horner syndrome is very slight or absent. Dilatation of retinal vessels is observed, and an increase in the colour of the optic disc. The effect on the retinal arterial pressure of a unilateral operation is (1) a transitory fall which is bilateral; (2) a bilateral rise lasting from one to five days, and very variable in amount; (3) a fall which is less marked than the initial fall, is bilateral and transient. After about eight days from the time of operation the arterial pressure is as before. Bilateral operation results in a fall of retinal arterial pressure, which is bilateral and followed by a much larger rise, and finally a slight fall. The first and third stages are less noticeable than in the unilateral operation, but the second stage is much more evident. Ocular tension shows very slight changes, either in the unilateral or bilateral operation. In general, a slight fall is noted. In eyes with a raised tension, however, there is a still further rise during the first twenty-four hours, and later a fall to the original pressure.

Six cases of operative result are reported. In one, bilateral operation was followed by definite functional improvement and increase of visual field in Leber's optic atrophy, but the benefit was lost after a subsequent operation in the region of the chiasma. Marked arachnoid proliferation in the neighbourhood was noted. A case of general paralysis, with optic atrophy of the tabetic type, had received no improvement during two years' vigorous anti-syphilitic treatment. After operation visual improvement continued for three months and was maintained for eleven months. A case of retinitis pigmentosa underwent the bilateral operation. Although no improvement had taken place in the condition for three years, definite benefit was reported after the operation.

It is pointed out that, according to Abadie, optic atrophy may be the result of vaso-constriction in arteries already diseased. The author cites two cases in which there was a remarkable degree of

obstruction of the lumen of the central retinal artery after death from cerebral haemorrhage, in patients whose vision had been satisfactory before death. The author also recalls the fact that the function of the optic nerve and the appearance in optic atrophy are not always in agreement, and suggests that, with vaso-dilatation resulting from operation, considerable benefit may result when both function and clinical appearance are bad. It is suggested that operation may benefit other conditions, such as atonic corneal ulcers, and retinal arterial spasm and ophthalmic migraine unaffected by acetylcholine.

HUMPHREY NEAME.

(6) **Bramwell, E. (Edinburgh)—Leaking aneurysm of the cerebral arteries as a cause of third nerve paralysis, with special reference to two cases in which the diagnosis was confirmed by arterial radiography. A note upon the aetiology of recurrent and periodic ocular palsy and ophthalmoplegic migraine.** *Trans. Ophthal. Soc. U.K.*, Vol. LIV, p. 205, 1934.

(6) Bramwell reports two cases of leaking aneurysm of the cerebral arteries which caused 3rd nerve paralysis. One of these was a married woman 23 years of age who, one hour after striking the back of her head against a mantelpiece, had severe left frontal headache and vomiting. Two weeks later she experienced intense pain around the left eye and complete left-sided ptosis and diplopia due to 3rd nerve paralysis became evident. Some neck rigidity was detected, but no blood was found in the cerebro-spinal fluid. Arterial radiography was performed by the injection of 15 c.c. of thorotrast into the left common carotid artery. This revealed an aneurysm 1 cm. in diameter in communication with the internal carotid artery by a narrow neck immediately below the point where it is joined by a large posterior communicating artery. After ligature of the internal carotid artery in the neck the retro-ocular pain passed off, and the ptosis and ocular movements recovered.

The author's other case was that of a married woman, 43 years of age, in whom loss of consciousness for half-an-hour was followed by headache and vomiting, and later, severe pain behind the left eye and in the back of the neck. These symptoms were followed by complete left 3rd nerve paralysis and later by paresis of the right arm and leg, slight papilloedema and xanthochromia in the cerebro-spinal fluid. An arterial radiograph showed two small rounded aneurysms on the internal carotid artery about the point where the posterior communicating artery joins it. The symptoms slowly cleared after ligature of the left common carotid artery, except for a slight limp with the right leg and the left pupil being larger than the right. Syphilis is an unusual factor in the aetio-

logy of aneurysm of the cerebral arteries. Sir William Church believed that nearly all cerebral aneurysms were due to embolism and associated with vegetative endocarditis; Eppinger holds the view that many aneurysms of the cerebral arteries are due to congenital defect of the medial coat of the arteries with, in some cases, subsequent degenerative and atheromatous processes. Fearnsides examined 51 cases of cerebral artery aneurysms at the London Hospital and found 36 were due to medial degeneration and 15 to infective emboli. Syphilis in no case was the cause and where cerebral artery aneurysm is diagnosed in the absence of infective endocarditis it is assumed that it is congenital in type. These aneurysms are small and like a berry; sites of predilection are points of bifurcation, junctions of the circle of Willis, and the region of the termination of the internal carotid artery at the point where the posterior communicating artery joins it.

The author discusses the aetiology of recurrent and periodic ocular paralysis and migraine and states that in many instances it is probable that there is a vascular basis to account for the nature of the attacks which begin with severe pain localized to the region of the eye, accompanied by vertigo and vomiting, with nerve paralysis developing a day or two later. Subsequently the headache disappears and then the ocular paralysis after a period, though permanent paresis may persist especially when repeated attacks have occurred.

He believes that these symptoms and train of events could be explained by temporary compression of a cranial nerve such as the 3rd or the 6th by a vascular paroxysm with subsequent recovery.

He quotes instances of anatomical anomalies where the posterior cerebral artery has been found looping round the 3rd nerve (Slater) and the 6th nerve compressed by a transverse pontine artery (Cushing).

He comments that the severe pain experienced in these cases was relieved by ligature of the internal carotid in one of his cases and in a case reported by Nattrass. Afferent fibres are found in the 3rd, 4th and 6th cranial nerves but from their distribution they appear to be entirely proprioceptive.

H. B. STALLARD.

(7) **Birch, C. A. (London).—Intra-cranial aneurysm.** *Post Grad. Med. Jl.*, p. 366, 1934.

(7) Birch describes 4 cases of aneurysm of the vessels forming the circle of Willis. All 4 were females, 3 died and 1 survived. Their ages were 19, 37, 47 and 59 respectively.

It is very difficult to diagnose an aneurysm before it ruptures or gives rise to pressure signs. Rupture is characterized by sudden

and severe occipital pain, neck rigidity and loss of consciousness. Paralysis of the oculo-motor nerve on the same side as the aneurysm and bilateral papilloedema with retinal and subhyaloid haemorrhages are later events. Coma and death terminate the clinical picture in a number of cases.

In two of the author's cases the aneurysm was about the size of a pea and situated at the junction of the middle cerebral and the posterior communicating arteries and the oculo-motor nerve was adherent to the aneurysm; in another case the aneurysm affected the middle cerebral artery near its origin and blood clot surrounded the oculo-motor nerve. Hemiplegia of the opposite side was present in 3 cases. In some of these cases Weber's syndrome, a lesion of the crus cerebri with complete nuclear oculo-motor palsy and hemiplegia of the opposite side, is evident.

The signs of pressure on cranial nerves come on some days after the initial symptoms. The papilloedema is believed to be due to blood in the arachnoid space compressing the central retinal vein.

In a few cases radiography is helpful in the diagnosis as showing erosion of bone, calcification in the wall of the aneurysmal sac and arterio-radiography.

In discussing the aetiology the author favours the conception that aneurysms of the circle of Willis occur at anastomotic junctions and at sites where there is some congenital defect in the tunica media of the vessel wall. Syphilis plays little or no part. Some cases may be due to embolism associated with subacute bacterial endocarditis and in rare instances to periarteritis acuta nodosa and arteriosclerosis.

H. B. STALLARD.

(8) **Lauber, J. (Warsaw).—The causation of papilloedema. (Die Enstehung der Stauungspapille).** *Wein. Klin. Wochenschr.*, December, 1934, p. 1537.

(8) As the result of many experiments the following conclusions were reached.

1. Retinal venous pulsation synchronous with carotid pulsation occurs at that moment when the intra-ocular pressure equals the retinal venous pressure.

2. The measurement of the amount of the retinal venous pressure gives a sufficiently accurate measure of the intra-cranial pressure.

3. In all cases of increased intra-cranial pressure, diastolic arterial pressure was raised whether papilloedema was present or not. This fact can only be used to estimate the actual intra-cranial pressure when the vascular system generally is normal whereas the measurement of the retinal venous pressure can be used directly as the expression of intra-cranial tension.

Based upon these measurements of the intra-ocular, venous and arterial pressures, after the manner of Bailliart, Lauber comes to the conclusion that the determining factor in the development of swelling of the optic discs and the accompanying phenomena is the raised diastolic retinal venous pressure and its increase in relationship to the diastolic retinal arterial pressure.

In all cases of increased intra-cranial pressure where the relationship between the minimal retinal venous and arterial pressures was as 1 : 1·7 and 1 : 1·26, there was no swelling of the discs. In those cases where the relation of these two pressures lay between 1 : 1·7 and 1 : 1·5 there was always hyperaemia of the discs and blurring of the edges. In those cases where the relationship was lower than 1 : 1·5 papilloedema invariably occurred.

Paton and Holmes have called attention to the fact that papilloedema is more marked in the eye with the lower intra-ocular pressure where a difference in this respect exists between the two eyes. In this connection the author quotes a case where papilloedema occurred in an eye as the result of low intra-ocular pressure alone. A patient with bilateral glaucoma had a cyclodialysis done on both eyes. In one eye tension became normal and the disc remained unaltered. The other eye had its tension much lowered and a swelling of the disc of about 2·5 D. developed together with fine haemorrhages. Gradually the tension increased and the disc became normal. A second glaucoma attack occurred for which an iridectomy was done and immediately the swelling of the disc recurred.

A. H. LEVY.

BOOK NOTICES

The Relation between Illumination and Industrial Efficiency. By Mr. H. C. Weston. H.M. Stationery Office. 1935. Price, 4d. This is the title of a publication by the Department of Scientific and Industrial Research, a Joint Report of its Illumination Research Committee, and the Industrial Health Research Board.

The research was undertaken at the National Physical Laboratory, where 18 members of the Photometric department have sat in relays in whitewashed cubicles of measured size, marking off on 6 cards, which contained a series of 256 broken rings of Landolt, those rings in which the break was at a particular point on the circumference. The size of the rings varied on each of the six cards and the cubicles had different degrees of illumination which ranged from 0·16 ft. candle to 500 ft. candles. The speed and accuracy at which the task could be done were measured.

The object of this research is to try and discover if a method can be worked out for determining the illumination necessary for any particular task. The details of the task are separated into such factors as size, contrast, movement, and perhaps colour, and the amount of illumination required for its efficient performance is determined. After the work has been analysed in this way it is hoped that it may be possible to bring the results together and express them in terms of the total illumination necessary for its most efficient performance. The present report deals only with the relationship between size of object and illumination and will be followed by others in which the other factors involved will be discussed.

The report shows that a definite relationship exists for each size between performance and illumination. The results obtained show that it is possible to find the relationship between size of work and illumination which will give a performance equal to a definite percentage of the maximum performance for the size under consideration.

An illuminating engineer is now in a position to state with regard to work of any given fulness of detail that a rate of performance equal to, *e.g.*, 98 per cent. of the maximum rate which could be obtained under unlimited illumination will be possible with an illumination of a certain definite number of foot candles. The relative cost of the various degrees of lighting can be estimated and then related to the total cost of performing the job under consideration. So instead of the empirical methods which have been employed to date the most effective and at the same time economical value of illumination can be reached on a scientific foundation.

The research is due to the suggestion of Mr. A. W. Beuttell of the Society of Illuminating Engineers; when the other components named have been analysed and the results recorded, a notable advance will have been made in the science of illumination.

Cataract, its Etiology and Treatment. By CLYDE A. CLAPP, M.D., F.A.C.S. Pp. 244, 92 illustrations. London: Henry Kimpton. Price, 18/-

The author has endeavoured to produce a comprehensive work on the embryology, anatomy, physiology and chemistry of the lens and to describe certain recent conceptions of the pathogenesis of cataract and its treatment. He states that a compilation of the vast amount of literature that has accumulated about the lens would be too voluminous for a single book. Instead he has selected for discussion works that are most generally accepted. Well established facts and some conceptions that are at present still mainly theoretical he has martialled and presented in as concise a manner as possible.

Chapters I and II on the development of the human lens and the comparative anatomy of the lens have been contributed by Miss Ida Mann. A chapter is devoted to congenital anomalies of the lens other than cataract.

The pathogenesis of cataract is discussed under a variety of headings such as toxic, radiant energy, vitamin-deficiency, kidney dysfunction, endocrine disturbance, cytotoxins and others. The reviewer is of opinion that the author could have with advantage amplified the clinical account of the pathogenesis of cataract and have made some fuller criticisms of this aspect of his subject. The same applies to the almost bewildering variety of operative procedures which he has described in the chapters dealing with the surgical treatment of cataract. The complexity of some of these manœuvres and their doubtful value merits sterner criticism than he has meted out. In a book that will be widely read by students and ophthalmic practitioners one feels that much emphasis should be laid upon the type of cataract operation that affords the minimum of danger to the patient with the maximum of technical simplicity and effectiveness for the average ophthalmic surgeon.

It is unfortunate that the dangers of retro-ocular injection of a local anaesthetic and of Lacarrère's diathermy coagulation technique for intra-capsular extraction are not stressed. In the case of the former severe orbital haemorrhage may necessitate abandonment of the operation and the complications that may attend the latter in the way of damage to the cornea and iris are not inconsiderable.

Pantocain is recommended as a local anaesthetic for cataract operations. The reviewer understands that although this excellent local anaesthetic has been retained for minor surgery it has been abandoned by many continental clinics for intra-ocular operations on account of its ineffectiveness in preventing capillary oozing.

The book is well written and presents a balanced up-to-date review of the lens, its diseases and their treatment. The illustrations are fair; there is a liberal bibliography at the end of every chapter and the book has been well produced.

Das Trachom. By Professor Dr. A. PETERS. Pp. 289. Berlin: Karger. 1935. Price, R.M. 16.

Professor Peters is Director of the Universitäts-Augenklinik in Rostock, Northern Germany, and has had adequate opportunity of becoming familiar with the clinical aspects of trachoma. His book is a serious study of the disease; it contains no illustrations, so the reader is not seduced by expensive pictures into an ill-founded estimate of the value of the publication. The author reasonably supposes that his book, written for trachomatologists, and not for ophthalmic surgeons who have little experience of

trachoma, does not require the usual pictures of trachomatous histology, or the illustration of well-known bacterial organisms or of H. P. K. (Halberstaedter-Prowaczek Körperchen).

The book is extremely well documented and should act as a guide to all who require to study trachoma intensively.

The chapter on the search for the cause of trachoma has been very carefully studied by the reviewer. While the names of a very large number of authors, and of the few who have undertaken serious experimental research are mentioned, it is disappointing to find no masterly survey of the present position of instructed opinion as to the cause of the disease.

Twenty First Annual Report of the Ophthalmic Section of the Department of Public Health of Egypt. 1933. Cairo: Government Press.

This report follows the usual lines of progress. There are now in Egypt 43 permanent hospitals and 14 travelling hospitals. The number of new patients seen was nearly a million and the operations numbered more than a quarter of a million. The incidence of blindness among patients seen has diminished from 15·6 per cent. in 1909, to 6·4 per cent. in 1933. The high incidence of primary glaucoma is noteworthy, 6,613 cases having been seen, or 0·79 per cent. of all new patients. Ophthalmic inspection and treatment are carried out at 32 Primary Government Schools where 98 per cent. of the pupils exhibited evidence of trachoma in its various stages. As the result of treatment the more serious stages of the disease were reduced by one half.

Report of the Ophthalmic Hospital of St. John of Jerusalem. 1934. Chancery of the Grand Priory in the British Realm of the Venerable Order of the Hospital of St. John of Jerusalem. Clerkenwell, London, E.C.1

The admirable work done in Palestine by the Grand Priory in the British Realm of the Venerable Order of the Hospital of St. John of Jerusalem for the relief of ophthalmias is well known, and has been referred to annually in this journal.

The Warden of the Hospital, Lieut.-Colonel Strathearn, C.B.E., is not only its Chief Ophthalmic Surgeon but includes among his duties the professional inspection of ten ophthalmic clinics maintained by the Department of Health of Palestine, each of which has a number of subsidiary ophthalmic centres in charge of a trained medical orderly.

Among the twenty thousand new patients at the Ophthalmic Hospital approximately eleven per cent. were blind in one eye and four per cent. were blind in both eyes. The greater proportion of these lost their sight as the result of acute conjunctivitis with

resulting corneal ulceration. It is probable that an overwhelming number of these were affected by trachoma.

The remarkably high percentage of primary glaucoma among the blind is noteworthy, being more than 6 per cent.

There has been a rise in blindness since the year 1928, which is correlated with a cycle of years with a rainfall much below the average. In Palestine, as elsewhere, dry years are associated with increased severity in the seasonal epidemics of acute conjunctivitis, by far the commonest cause of blindness.

A praiseworthy effort is being made to teach Arab girls some elementary ocular hygiene. However, when one has to remember that in many distant villages water is rationed with eye-dropper economy it is difficult to envisage any rapid advance.

It is of importance to note that approximately 74 per cent. of the patients were of the Moslem faith.

OBITUARY

JULES GONIN

PROFESSOR JULES GONIN, whose death on June 11 was briefly noted in our last number, was born at Lausanne on August 10, 1870. On his father's side he was descended from a Protestant family of refugees from the valleys of Piedmont who had settled in the canton of Vaud. On his mother's side he was connected with Berne.

His early years of study were passed at the College Galliard and later in the Cantonal Gymnasium. He next entered the faculty of Science of the old Academy, then the faculty of Medicine at Lausanne, and later that at Berne.

His first introduction to ophthalmology occurred while still an undergraduate when he served as *locum tenens* to the resident officer at the Hôpital de l'Asile des Aveugles, where, in 1896, he became the resident officer. In 1899, after a tour of study in foreign countries, he became chief assistant, and in 1901 second Associate-Surgeon.

In 1918 he became Surgeon in Charge of the Asile des Aveugles, and in 1920, on the death of Professor Eperon, Professor of Ophthalmology in the University.

Although ophthalmology was his life's work, Professor Gonin had many other interests. He was an active member of the Alpine Club and made many ascents, preferring glaciers to rocks. He had a profound knowledge of every corner of Switzerland. He was a great traveller and had explored the whole of Europe as well as

Palestine and Egypt. He had the gift of languages: not only was he an adept in all the various dialects of Switzerland but could speak fluently in many other languages including Spanish, Serbian, Modern Greek and Arabic. Even after he had passed middle life he learned new languages. He spoke of this knowledge in terms of the gramophone, saying, that when about to speak English he would put on his English gramophone record.

He was one of the founders of the Swiss Ophthalmological Society in 1908, and attended all the meetings with the exception of the last which took place fifteen days before his death.

In politics he was a liberal, and following his father, he was a fervent supporter of proportional representation.

Coming now to his scientific work, without doubt the name of Gonin will always be associated with the cure of detachment of the retina, but his serious work on this subject did not begin until 1918.

Before this date, his communications were numbered by the dozen. He gained his laureate at the University by his work on the development of the wings of the butterfly in the chrysalis. The butterfly was always his favourite, and his consulting room was decorated by actual specimens pinned to the ceilings and walls.

His thesis for the Doctorate was on the regeneration of the crystalline lens.

His aptitude for drawing, and the need he felt for elaborate note-taking certainly has made for much of the accuracy which characterized his works.

In 1898 he began his ophthalmological publications: at first they had an anatomical and pathological character with an examination of macroscopical and microscopical specimens, or dealt with the bacteriology of ocular affections. Later on, clinical observations played a greater rôle, one group concerning the annular scotoma of retinitis pigmentosa in which he showed that concentric diminution of the field of vision is often only annular, and that when it is really concentric it is but the terminal stage of an annular scotoma which has reached the periphery.

In 1900 Professor Dufour was entrusted with the re-writing of the large chapter ('Diseases of the Retina and Optic Nerve') for the French Encyclopaedia of Ophthalmology, and he collaborated with his devoted pupil Gonin. Thus it happened that Gonin had to take notice of all that had been said or written on diseases of the retina. It was this work that gave birth to his ideas on the causes of detachment of the retina, its pathology, the importance of rents and so on.

Gonin also wrote the chapter on amaurosis and amblyopia for the Encyclopaedia.

The first work of Gonin on detachment of the retina appeared

in 1908, but it was in 1918 that a paper 'The Anatomical Causes of Detachment of the Retina' conducted oculists to the point they have reached to-day. Thirty-eight publications of greater or less importance were made by Gonin on this subject between 1918 and 1934, and in 1934 appeared his large book 'Detachment of the Retina' which crowned his work.

It is necessary to go back seventy years in the history of ophthalmology, to the introduction by von Graefe of the curative value of iridectomy for glaucoma, to meet with a discovery comparable with that of Gonin's.

Oculists from all parts of the world visited Lausanne to be welcomed by this charming and vivacious man who spent much of his time in explaining to all his views, and if opportunity arose, showing them the details of the operation he had devised.

Professor Gonin, besides being a member of the Swiss Ophthalmological Society, was also a member of the French Society and that of Heidelberg.

In 1929 he was awarded the Marcel Benoist prize, and in 1934 he visited Glasgow to give the William Mackenzie Memorial lecture, and to receive the Mackenzie Medal.

NOTES

Death

WE regret to record the death of Reginald Arthur Yeld, M.A., M.D.Cantab., of Edgewood, British Columbia, on April 3, 1935. Dr. Yeld was born in London and educated at Cambridge University and St. Bartholomew's Hospital, where he acted as ophthalmic house surgeon. He began practice in Hampstead but migrated to British Columbia about 20 years ago. Always interested in ophthalmology, Dr. Yeld was well known over a wide area for his work on refraction. In 1932 he published privately a thesis on "Accommodation in the Human Eye," which was reviewed in our columns in January last.

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Knapp Memorial Lecture

THIS lecture was delivered before the ophthalmological section of the American Medical Association on June 12, by Mr. Leslie Paton, who has been elected an hon. member of the Association as well as of the Association for Research in Ophthalmology.

The subject of the lecture was "Papilloedema and Optic Neuritis —a Retrospect." At the conclusion Mr. Paton was presented with the Knapp Memorial Prize.

FUTURE ARRANGEMENTS

1935

October 1.—Midland Ophthalmological Society, at Birmingham Eye Hospital.

December 3.—Midland Ophthalmological Society, at Birmingham Eye Hospital.

CONTEMPORARY OPHTHALMIC LITERATURE

American Journal of Ophthalmology. *June, 1935.*

BIELSCHOWSKY. The influence of exophthalmos on the function of paretic ocular muscles.

BERENS, PAYNE and KERN. Orthoptic training and surgery in hyperphoria and hypertropia combined with lateral deviations.

CASTROVIEJO. Goniophotography.

LUCKIESH and MOSS. Reflex effects from critical seeing.

JONES. Oil cyst of the orbit with carcinomatosis.

MORRIS and JULIANELLE. A study of an ocular infection induced experimentally with bacterium monocytogenes.

DAVIES. Megalophthalmus.

VON DER HEYDT. The aging lens.

LYON. Conjunctival myiasis.

LANGDON. Partial detachment of the retina treated successfully with Shahan's thermophore.

LEBENSOHN. Primary carcinoma of the Meibomian gland.

Annales d'Oculistique. *June, 1935.*

WESKAMP. Optic atrophy and malaria therapy.

CHEVTCHOUK. Infantile traumatism according to data from the ophthalmic clinic of the Kiew Institute of Medicine during 25 years.

DASCALOPOULOS. The treatment of purulent ulcer by galvano-puncture of the cornea.

Archives d'Ophtalmologie. *June, 1935.*

BONNET and COLRAT. Contribution to the anatomico-clinical study of inflammatory tuberculosis of the iris.

GABRIELIDES. Contribution to the study of electric cataracts.

HUDELO. Traumatic proliferation of the iris pigment and iris cyst.

FRANÇOIS. B.coli in ocular pathology.

CAZALIS and DUGUET. Unilateral exophthalmos by compression of the cervical sympathetic in the neck.

Revue d'Oto-Neuro-Ophtalmologie. *April, 1935.*

ROGER and ALLIEZ. Aetiology of the syndromes of the sphenoidal fissure and orbital apex. Efficiency of anti-syphilitic treatment.

RAMADIER, GUILLON and MORANCE. Blindness (with papilloedema and central scotoma) and intra-nasal intervention.

AUBARET, JAYLE and APPAIX. Examination of the vestibular responses in 11 squinters and 2 unilateral myopes; normal responses or vestibular hypo-excitability.

GUILLOT and PAILLAS. Semeiological value of the retinal artery pressure in intra-cranial hypertension.

May, 1935.

TILLÉ. Ocular manifestations of suppurative otitis and its complications.
ROGER, ALLIEZ and PAILLAS. Retinal neuroectoderm concurrent with the cutaneous syndrome of Recklinghausen.
NORDMANN, PAYEUR and SACREZ. About a case of Schüller-Christian disease.

Revue d'Optique. *April, 1935.*

MARTON. The electronic microscope and its uses.

Klinische Monatsblätter für Augenheilkunde. *June, 1935.*

VISSER-HEEREMA and WEVE. Results produced in the University Ophthalmic Clinic, Utrecht, of the treatment of retinal detachment by diathermy during 1933-34.
BRAUN. Familial occurence of Drusen bodies on the papilla.
LUDWIG. The diagnosis of juvenile retinal haemorrhage.
KNAPP. Contribution to the question of periphlebitis and endophlebitis obliterans.
VON SZILY. Experiment as to the transmissibility of trachoma material to hens. Further contribution to the knowledge of follicles formed by excitation.
SCHEURLEN. Inheritance of pigment degeneration of the retina and its dissemination in Württemberg and Hohenzollern.
NEDDEN. The theory and practice of traumatic retinal detachment.

Bollettino d'Oculistica. *May, 1935.*

CHARLIN. Masked trachoma.
FOCOSI. Considerations on the pathogenesis of filamentous keratitis.
ORZALESI. A case of primary glioma of the iris.
STRAMPELLI. Diaphanoscopic diathermy.
ANELLI. A preparation of colloidal zinc in the cure of catarrhal conjunctivitis.
NASTRI. Purulent conjunctivitis and palpebral pyodermatitis from micrococcus catarrhalis.
CAMPOS. Clinical and histological research on punctate cataract.
FILIPPI-GABARDI. Xeroderma pigmentosa with ocular lesions.
CAOCCI. Contribution to the knowlege of familial macular degeneration.

Folio Ophthalmologica Orientalia. *September-December, 1934.*

KIRWAN. Epidemic superficial punctate keratitis in Bengal.
MACHT. Phytopharmacological studies on the blood of trachoma patients.
ZYKULENKO. Removal of the Meibomian glands in latent trachoma.
BUSACCA and MAIA. Chronic oedema of the eyelids due to Leishman bodies.
MITERSTEIN. Leishmaniosis of the lid.
SCHMERL. The theory of cataract genesis.
REIS. A literary document on glasses of the beginning of the 14th century.
CHARAMIS. Further results after the application of newer operative methods for retinal detachment.

Revista Oto-Neuro-Oftalmologica y de Cirugia Neurologica. *June, 1935.*

PAVIA. Fundus of the eye.
TOURNAY. The alliance between oto-neuro-ophthalmology and the vegetative nervous system.

Revista Cubana de Oto-Neuro-Oftalmiatria. *January-February, 1935.*

POYALES. Pathogenesis and treatment of retinal detachment.
CEPERO and COMAS. Corneal ulcers treated by diathermy.
ESTEBAN. Curious hemianopic manifestations.